USING SYNTHETIC BIOLOGY TO ENGINEER FUNCTIONAL PROTEIN-BASED MATERIALS

Noémie-Manuelle Dorval Courchesne, Department of Chemical Engineering, McGill University, Canada
noemie.dorvalcourchesne@mcgill.ca
Zahra Abdali, Department of Chemical Engineering, McGill University, Canada
Dalia Jane Saldanha, Department of Chemical Engineering, McGill University, Canada

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While conventional organic polymers and plastics have served various needs of our society for decades, they present important limitations, such as limited biodegradability, biocompatibility and chemical tunability. Protein-based materials represent sustainable, non-toxic and versatile alternatives to these organic polymers. In fact, synthetic biology now allows us to easily customize the sequence of self-assembling proteins to modify their chemical and physical properties. In particular, amyloid proteins can assemble into nanofibers with high surface area, which can be used as structural or genetic scaffold for a variety of applications. Curli nanofibers are a class of amyloids naturally produced by *Escherichia coli* bacteria to promote surface adhesion and biofilm formation. After extracellular secretion of the curli subunits (CsgA), they self-assemble to form highly resistant functional nanofibers. The curli subunits exhibit exceptional structural and mechanical stability, and can be engineering to form a variety of fusion proteins or to display functional point mutations. Through a scalable vacuum filtration-driven process (Figure 1), our group isolates aggregated engineered proteins to form a range of macroscopic materials, including protein hydrogels and free-standing films.[1] The simplicity and scalability of this process allows us to move towards the fabrication of protein-based biopolymers, coatings and composite materials for environmental, energy and biomedical applications.

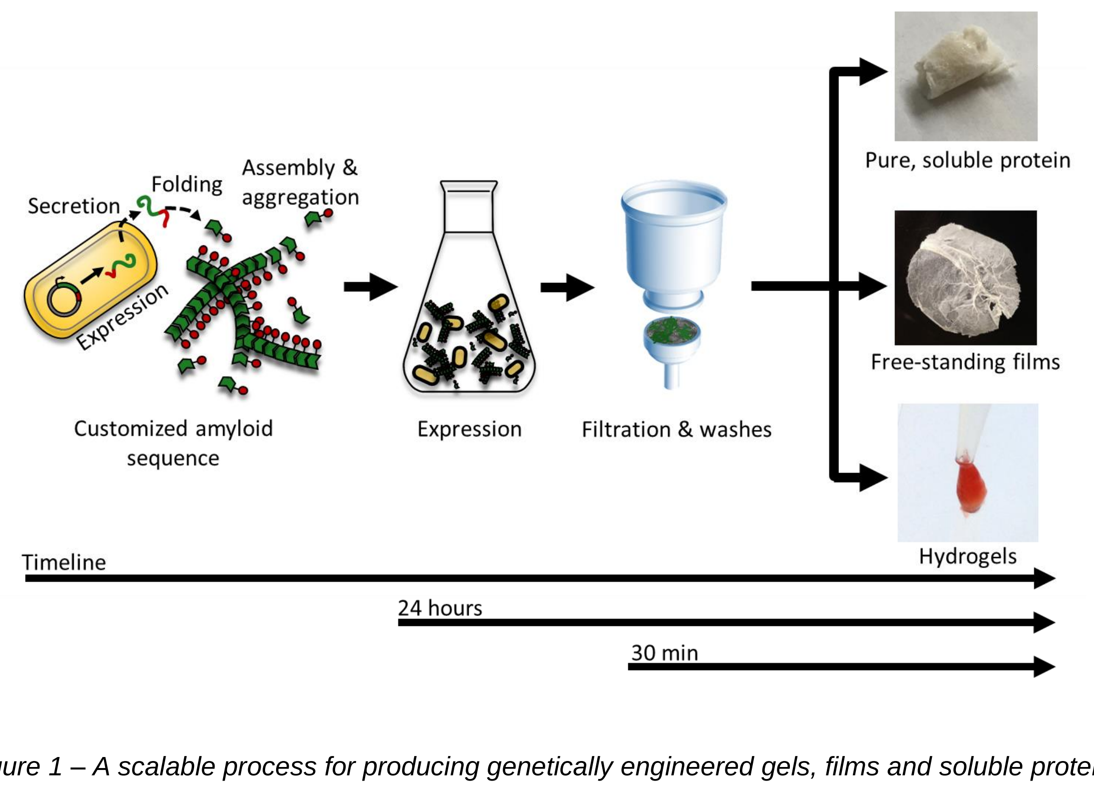

Figure 1 – A scalable process for producing genetically engineered gels, films and soluble protein.[1]

1. Dorval Courchesne, N.-M., Duraj-Thatte, A., Tay, P. K. R., Nguyen, P. Q. & Joshi, N. S. Scalable Production of Genetically Engineered Nanofibrous Macroscopic Materials via Filtration. *ACS Biomater. Sci. Eng.* 3, 733–741 (2017).